Developmen of the Cassini Spacecraft Prepulsion Subsystem

Michael W. Leeds, Jet Propulsion Laboratory, Pasadena, California
and
Ralph N. Eberhardt and Robert L. Berry, Lockheed Martin Astronautics, Denver, Colorado

The Cassini Spat.czmft will be launched on an expedition to Saturn in October 1997. The mission is an eleven-year operation, the first seven years traveling 10 Saturn via a combination of propulsive burns and Venus-Venus-Earth-Jupiter gravity-assist, and the, remaining four years orbiting Saturn while exploring the planet, it's moons, rings and nearby icy satellites. The Propulsion Module Subsystem (PMS) provides thrust and torque to the spacecraft. Larger delta-v maneuvers are conducted with a primary (with redundant backup) pressure-regulated 445-N engine, which burns nitrogen tetroxide (NTO) and monomethylhydrazine (MMH); the total propellant capacity is 3000 kg. These engines are gimbaled so that, under avionics control during burns, the trust vector can be maintained through the spacecraft center of mass. Saturn Orbit Insertion (Sol) is accomplished with a 200-minute (maximum duration) continuous firing of the bipropellant engine. Attitude control of the spacecraft is maintained by a reaction control system that consists of four thruster cluster assemblies mounted off the. PMS core. structure, near the base of the spacecraft. The 1-N thrusters (arranged in two redundant pairs per ciu st cr) operate in a blowdown mode., with the. monopropellant tank (containing 132 kg of hydrazine) recharged Once from a dedicated helium pressurant tank to raise the thrust level in support of Saturn orbital operations.

The PMS is specially configured to meet the. arduous 11 -year mission requirements, inducting the thermal excursions encountered with the particular mission trajectory. A unique feature of the system design is the use of numerous pyro valves to control bipropellant vapor migration during the extensive non-operating coast periods inherent in such a long mission. A significant development program was implemented to provide design verification of major assemblies, and to extend the performance capabilities of heritage components. Integration and test program activities and status arc discussed, as wc]] as the development status of all subsystem assemblies. The use of specially designed electrical ground support equipment and high fidelity simulators has provided a high degree of confidence in the performance of the flight hardware, which is currently in the final integration and test phase prior to shipment to JPL for integration with the spacecraft.